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Chondrogaster pachysporus in a *Eucalyptus* plantation of southern Brazil

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Abstract — *Chondrogaster pachysporus* is reported for the first time in Brazil. It is similar to *C. angustisporus*, also known from southern Brazil, but differs in the size and ornamentation of the basidiospores and in the presence of monosporic basidia. The hypogeous sequestrate specimens were collected in a *Eucalyptus saligna* plantation. Descriptions, photographs, and line drawings of the specimens are presented.

Key words — ectomycorrhiza, false-truffle, *Hysterangiales*, *Mesophelliaceae*

Introduction

Chondrogaster Maire is a genus of sequestrate fungi characterized by enclosed hypogeous basidiomata that bear a loculate gleba composed of tramal plates where basidia and basidiospores are produced (Castellano et al. 1989). The genus is closely related to *Hysterangium* Vittad., from which it was segregated and differs in the lack of a distinct columella and presence of a mycelial mass covering the whole basidioma (Giachini et al. 2000). Both currently known species are associated with *Eucalyptus* and possibly native to Australia but have spread to many areas where *Eucalyptus* plantations have been established for forestry purposes.

Chondrogaster angustisporus Giachini et al., originally described from Australia, Uruguay, and southern Brazil (Giachini et al. 2000), is possibly the only South American record of the genus. *Chondrogaster pachysporus*, the type

species, is so far known from the Mediterranean zone (Europe and Africa), North America, and Australia (Lago & Castro 2004). Recent studies on the biology and taxonomy of sequestrate fungi in Brazil and neighboring countries are scarce and limited to a few local revisions from Brazil (Giachini et al. 2000, Cortez et al. 2008) and Argentina (Nouhra et al. 2005, 2008). In this paper, we report the occurrence of *C. pachysporus* in southern Brazil.

Materials and methods

Fieldwork was conducted in a *Eucalyptus saligna* Sm. plantation at the Experimental Forestry Station (FEPAGRO), in the municipality of Santa Maria, central region of Rio Grande do Sul State, southern Brazil (29°45' S, 53°43'W). The site comprises 280 ha for cultivation of native trees as *Apuleia leiocarpa* (*Caesalpiniaceae*), *Senna multijuga* (*Caesalpiniaceae*), and *Tabebuia* spp. (*Bignoniaceaae*), and exotics as *Hovenia dulcis* (*Rhamnaceae*), *Platanus×acerifolia* (*Platanaceae*), *Pinus* (*Pinaceae*), and *Eucalyptus* spp. (*Myrtaceae*). Soil is of the Hapludult type, which is deep, imperfectly drained and with low natural fertility (Abrão et al. 1988, Streck et al. 2008). Climate is subtropical humid (Cfa) according to Köppen's system, with mean temperature values for the warmest month higher than 22°C (Menegat 1998). Annual rainfall is about 1769 mm, with rains well distributed throughout the year (Schumacher et al. 2008).

Fresh basidiomata were collected and photographed in situ, then analyzed macro- and microscopically following Brundrett et al. (1996) and Castellano et al. (2004). Color names and codes follow Kornerup & Wanscher (1978). Microscopic analysis of the basidiomata comprised 30 measurements of each microstructure (basidiospores, basidia, and hyphae), which were drawn under a light camera. Specimens are deposited in the herbaria of Department of Biology, "Universidade Federal de Santa Maria" (SMDB) and the Institute of Biosciences, "Universidade Federal do Rio Grande do Sul" (ICN).

Taxonomy

Chondrogaster pachysporus Maire, Bull. Soc. Mycol. Fr. 40: 312, 1925. Fig. 1–8

Basidiomata hypogeous, 8–23 mm in width, 7–11 mm high, depressed globose to subglobose, aggregated in clusters within a common mycelium. Peridium <1 mm thick, greyish beige (4C2) when fresh, dull red (9C4) when bruised, glabrous or covered by scattered to numerous rhizomorphs. Gleba composed by non-gelatinized, radially arranged locules, greyish green (28C3) to dull green (29D3) at younger stages, to finally olive (1F5) or blackish at maturity. Rhizomorphs white, numerous, arising from several points of attachment in the basidiomata surface. Columella absent.

Basidiospores 12.5–16.5 × 6–9 µm (ornamentation excluded), subfusoid, ellipsoid to broad ellipsoid, apex and base tapered, some with a shortly mucronate apex; sterigmal attachment persistent at maturity; in KOH, they are hyaline when young to finally pale yellowish brown at maturity; wall smooth

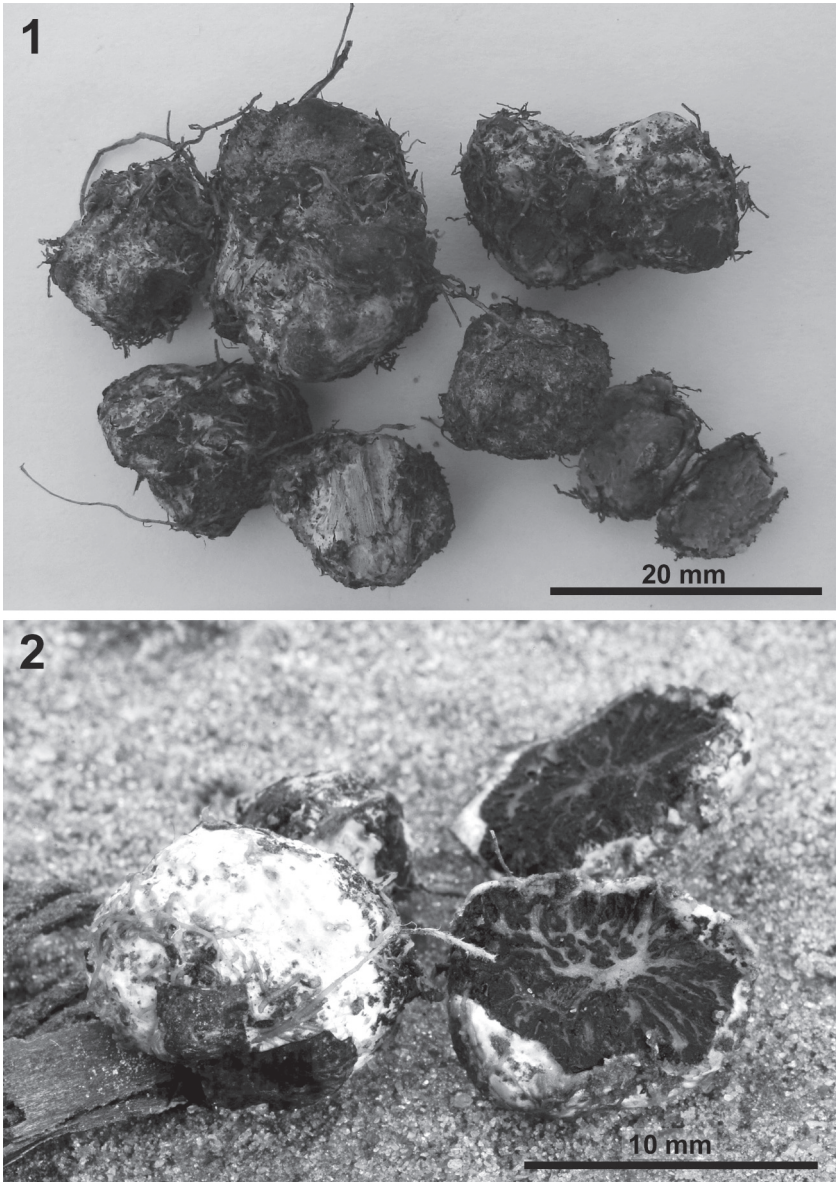


Fig. 1-2. Basidiomata of *Chondrogaster pachysporus.* (1. Sulzbacher-192; 2. Sulzbacher-196)

when young, becoming irregularly reticulate at maturity and of variable diameter (<3 µm).

Basidia monosporic, 31–52 × 4–16.5 µm, hyaline, subcylindrical, with constricted base and apex, clamp connections common, collapsed in mature specimens. Peridium separable from the gleba, 2-layered: a) external layer formed by yellowish brown, thick-walled, clamped hyphae (4.2–11 µm diam.) mixed with abundant soil particles; b) internal layer composed by hyaline, smooth and thin-walled hyphae, compactly interwoven, filamentous to subglobose 4–27.5 µm diam. Trama 30–100 µm thick, not gelatinized in young basidiomata, becoming gelatinized in mature specimens, constituted of hyaline, smooth, thin-walled, and compactly interwoven hyphae, 3.2–5.5 µm diam., clamp connections rare.

Distribution: Australia and United States (Bougher & Lebel 2001), North Africa (Lago & Castro 2004), Spain (Lago & Castro 2004, Moreno-Arroyo et al. 2005), Portugal (Calonge & Vidal 2000), France and Italy (Lago & Castro 2004). Probably widespread with eucalypt trees.

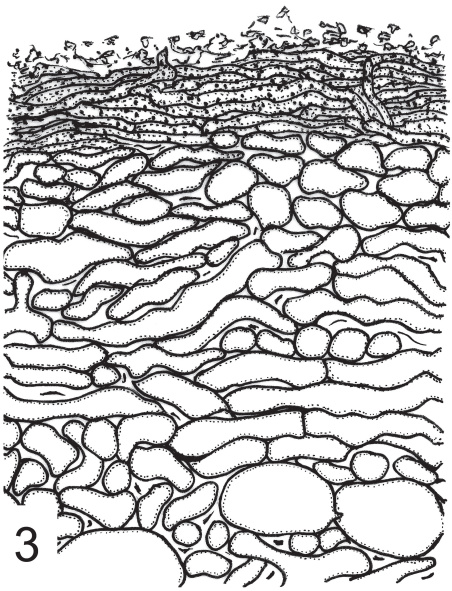
Specimen examined: **BRAZIL**. Rio Grande do Sul: Santa Maria, Boca do Monte District, Estação Experimental de Silvicultura-FEPAGRO, 21 April 2009, *leg. M.A. Sulzbacher 191* (SMDB 12.920); *ibid*., 06 May 2009, *leg. M.A. Sulzbacher 192* (SMDB 12.921); *ibid*., 10 July 2009, *leg. M.A. Sulzbacher 196* (SMDB 12.922; ICN 154459).

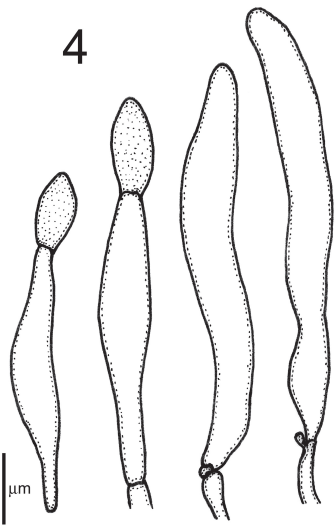
Comments — The genus *Chondrogaster* was considered in the past as a member of the *Melanogastraceae* E. Fisch. (Zeller 1949), *Hysterangiaceae* E. Fisch. (Bougher & Lebel 2001), and *Chondrogastraceae* Locq. (Giachini et. al. 2000). However, molecular phylogenetic analysis places the genus is currently placed in the *Mesophelliaceae* Jülich of the *Hysterangiales* K. Hosaka & Castellano (Hosaka et al. 2006).

Chondrogaster pachysporus, originally described by Maire from Mauritania (Africa), constitutes the type species of the genus, which until recently was considered monotypic (Giachini et al. 2000). Although it is associated with widely cultivated *Eucalyptus* spp. in the world, this species has been poorly documented, probably due to its underground cryptic habit, as most mycologists pay little attention to hypogeous fungi.

As far as we know, this is the first record in South America. *Chondrogaster angustisporus*, which has been reported from southern Brazil, Australia, and Uruguay (Giachini et al. 2000), differs from *C. pachysporus* in the narrower basidiospores (10–15 × 4–5 µm) covered by a less coarse ornamentation and the presence of mostly bisporic basidia within the glebal locules (Lago & Castro 2004). In contrast to our specimens, which were collected under *E. saligna*, *C. angustisporus* has been found under *E. dunnii* Maiden in southern Brazil as well as several other *Eucalyptus* species in Australia (Giachini et al. 2000).

Lupatini et al. (2008) characterized southern Brazilian strains of *C. angustisporus* through mycorrhizal morphotyping and ITS (rRNA) sequences. Their





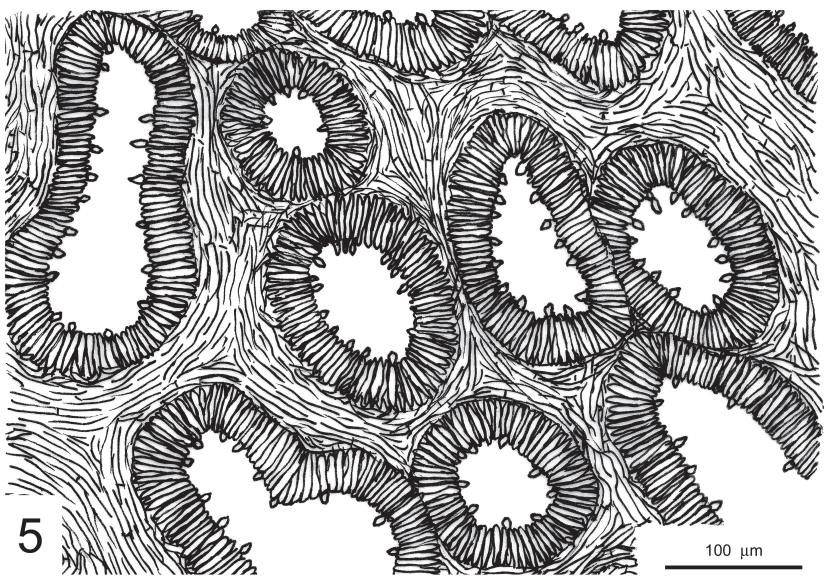


Fig. 3-5. *Chondrogaster pachysporus*. 3. Peridium. 4. Basidia. 5. Gleba structure.

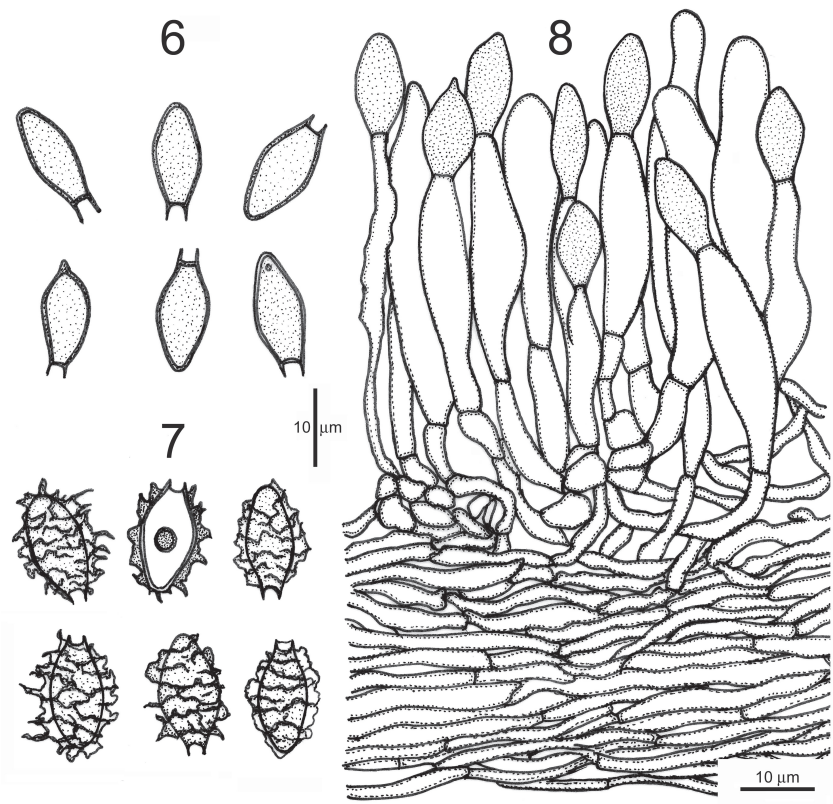


Fig. 6-8. *Chondrogaster pachysporus.*
6. Immature basidiospores. 7. Mature basidiospores. 8 Detail of the hymenium and trama.

results supported strong relationships among other taxa in the gomphoid-phalloid clade (e.g. *Gautieria*, *Gloeocantharellus*, *Gomphus*, *Hysterangium*, *Ramaria*, and *Sphaerobolus*). In two recent molecular phylogeographic studies of *Hysterangiales, Andebbia pachythrix* (Cooke & Massee) Trappe et al. clustered with *C. angustisporus* and *C. pachysporus*, suggesting a close relationship between them (Hosaka et al. 2006, 2008).

The present report from southern Brazil considerably extends the known world distribution of *C. pachysporus.* The new record arises from ongoing investigations of hypogeous fungi associated with *Eucalyptus* in the state of Rio Grande do Sul. As this research progresses, we hope to provide additional data on their diversity and biology.

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